Geophysical Research Abstracts
Vol. 17, EGU2015-10850-1, 2015
EGU General Assembly 2015

Employing multi-objective Genetic Programming to the downscaling of near-surface atmospheric fields

Tanja Zerenner, Victor Venema, Petra Friederichs, and Clemens Simmer
Meteorological Institute, University of Bonn, Germany

The coupling of models for the different components of the Soil-Vegetation-Atmosphere-System is required to investigate component interactions and feedback processes. However, the component models for atmosphere, land-surface and subsurface are usually operated at different resolutions in space and time owing to the dominant processes. The computationally expensive atmospheric models are typically employed at a coarser resolution than land-surface and subsurface models. Thus up- and downscaling procedures are required at the interface between the atmospheric model and the land-surface/subsurface models.
We apply multi-objective Genetic Programming (GP) to a training data set of high-resolution atmospheric model runs to learn downscaling rules, i. e., equations or short programs that reconstruct the fine-scale fields of the near-surface atmospheric state variables from the coarse atmospheric model output. Like artificial neural networks, GP can flexibly incorporate multivariate and nonlinear relations, but offers the advantage that the solutions are human readable and thus can be checked for physical consistency. Further, the Strength Pareto Approach for multi-objective fitness assignment allows to consider multiple characteristics of the fine-scale fields during the learning procedure.
We have applied the described machine learning methodology to a training data set of 400 m resolution COSMO model runs to learn downscaling rules which recover realistic fine-scale structures from the coarsened fields at 2.8 km resolution. Hence we are currently downscaling by a factor of 7. The COSMO model is the weather forecast model developed and maintained by the German Weather Service and is contained in the Terrestrial Systems Modeling Platform (TerrSysMP), which couples the atmospheric COSMO model to land-surface model CLM and subsurface hydrological model ParFlow. Finally we aim at implementing the learned downscaling rules in the TerrSysMP to achieve scale-consistent coupling between atmosphere and land-surface/subsurface.
The presentation will cover the multi-objective GP methodology as well as examples illustrating its performance for downscaling of near-surface temperature. The multi-objective GP methodology constitutes an advancement compared to linear regression conditioned on indicators especially for nights with strong radiative cooling. Although GP produces potentially nonlinear solutions, overfitting tendencies are only evident for few exceptions.